Inclusion of CPO channels in the 400G/lane Optical Specifications

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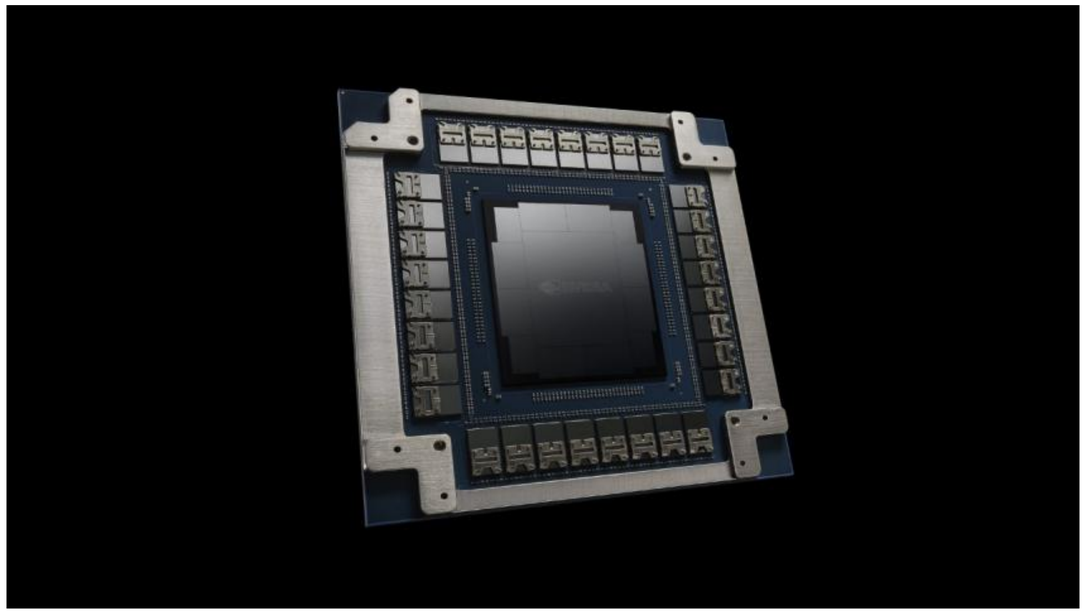
400G Optical Tx Specification

A Proposal for including CPO channels

- Optical compliance tests in IEEE have so far been catering to Pluggable form factors with various combinations of integrated or discrete Drivers, TIA's and modulators.
- CPO is an upcoming technology that uses integrated silicon-based Drivers and Modulators co-packaged with the ASIC.
- The bandwidth of CPO-based optical signals at TP2 is lower for two reasons:
  - Use of lower BW integrated Silicon Photonic components
  - Higher loss between the Optical Engine and the ASIC on the MCM



- **We propose that the specification accommodate these new technologies while acknowledging their special requirements.**

400G Optical Specification

FFE + DFE TDECQ Reference Rx

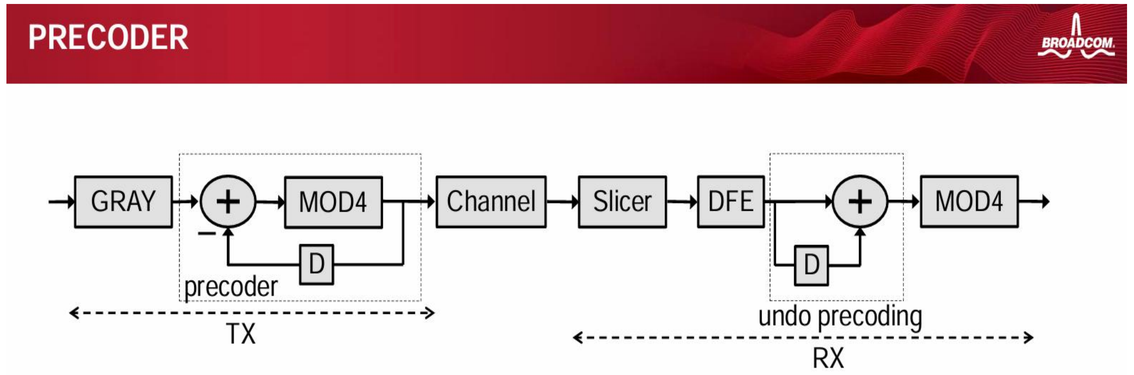
- Propose to use 23-tap FFE +1-tap DFE for the TDECQ reference Rx

- With low BW transmitter components, allowing for a larger range for DFE tap, say [0, 0.7], will help to avoid excessive boost which in turn helps to avoid noise amplification.

  - Error propagation concerns with the allowance of larger DFE tap can be mitigated by enabling Tx Pre-Coder (MOD4/[1+D])

  - The Rx can negotiate Precoding to be enabled during link-up, only for those channels that need the higher DFE tap

- Cathy Liu from Broadcom has previously analyzed the benefit of the Pre-Coding with 100 Gbps PAM4 signaling.
  - Please refer to: **Cathy Liu, "100+ Gb/s Ethernet Forward Error Correction (FEC) Analysis", DesignCon 2019.**

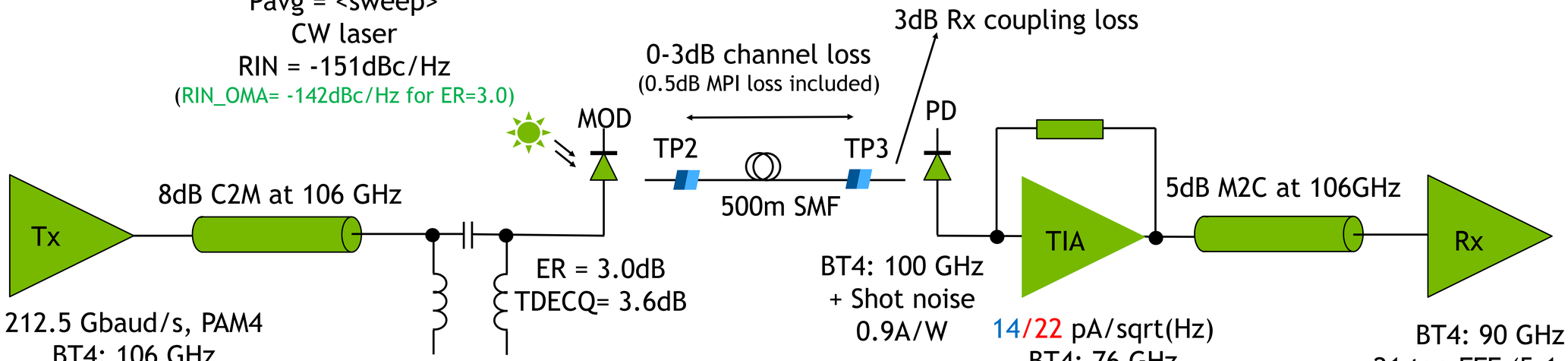


Reference: Tx Differential Precoder Simulation Results & Proposal for CDAUI-8 C2C

400G Optical Channel

FFE + DFE

Pavg = <sweep>
CW laser
RIN = -151dBc/Hz
(RIN_OMA= -142dBc/Hz for ER=3.0)



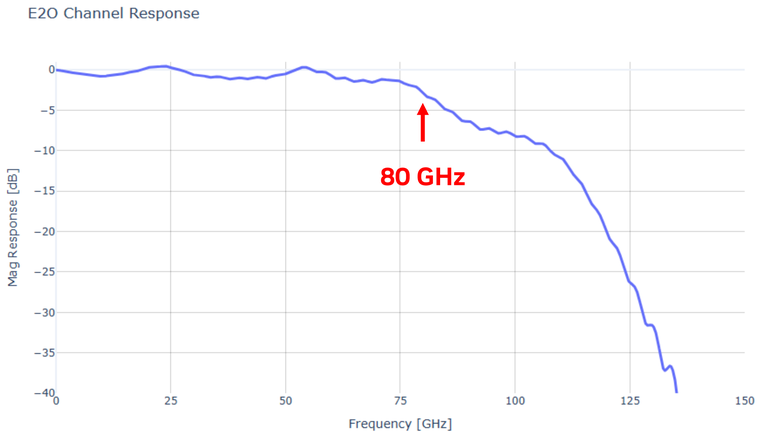
212.5 Gbaud/s, PAM4
BT4: 106 GHz
6b ENOB
Tx pre-coding
5-tap TxFIR (2-1-2)

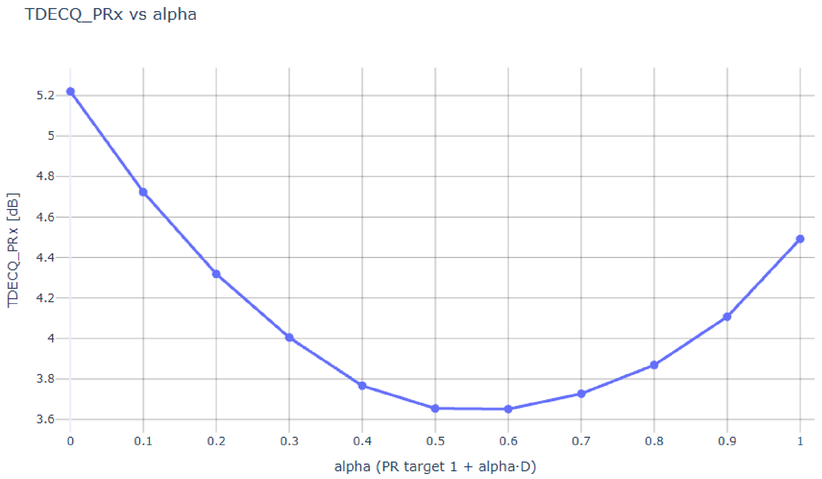
BT4: 100 GHz
+ Shot noise
0.9A/W

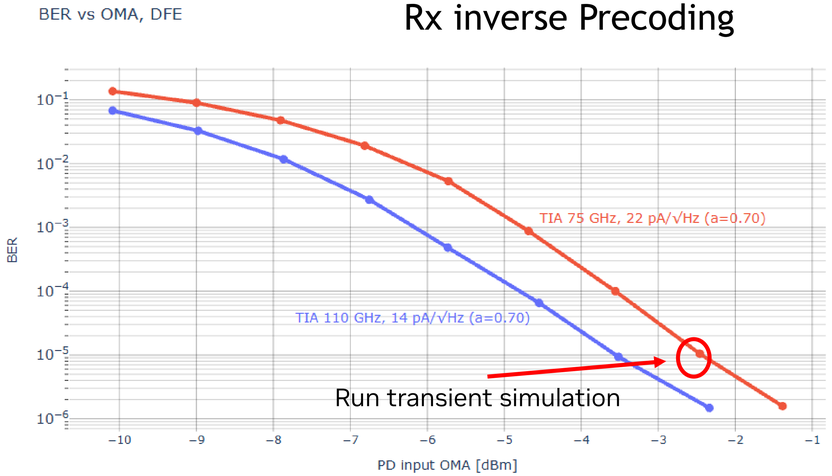
14/22 pA/sqrt(Hz)
BT4: 76 GHz

BT4: 90 GHz
21 tap FFE (5-1-15)
+
1-tap DFE
+
Rx inverse Precoding

TP2

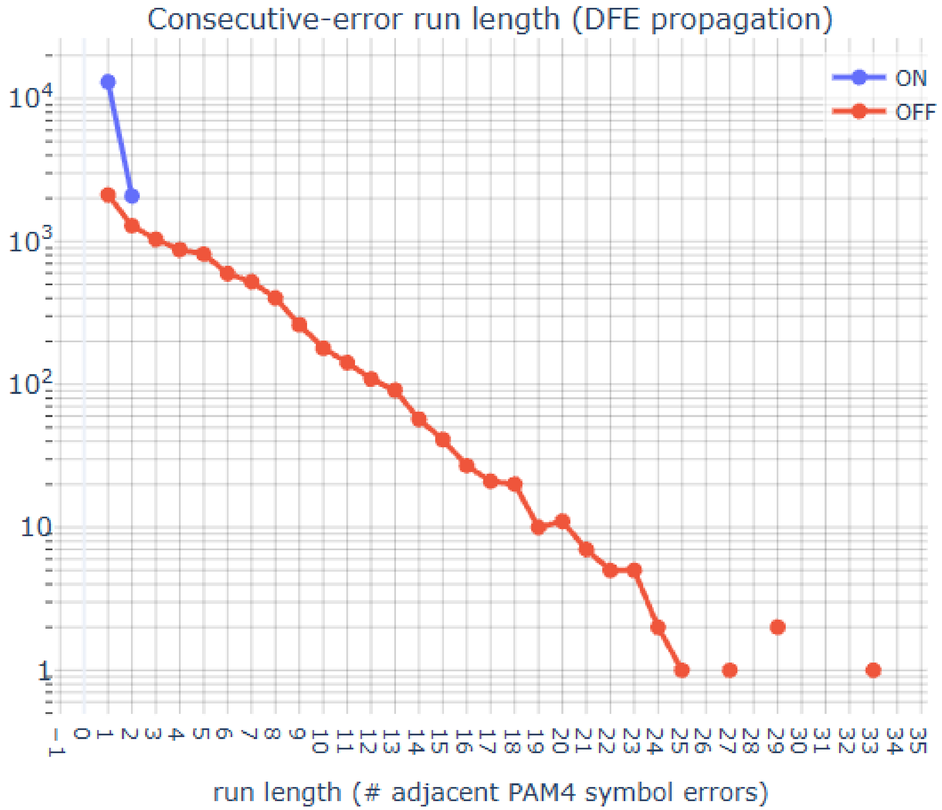


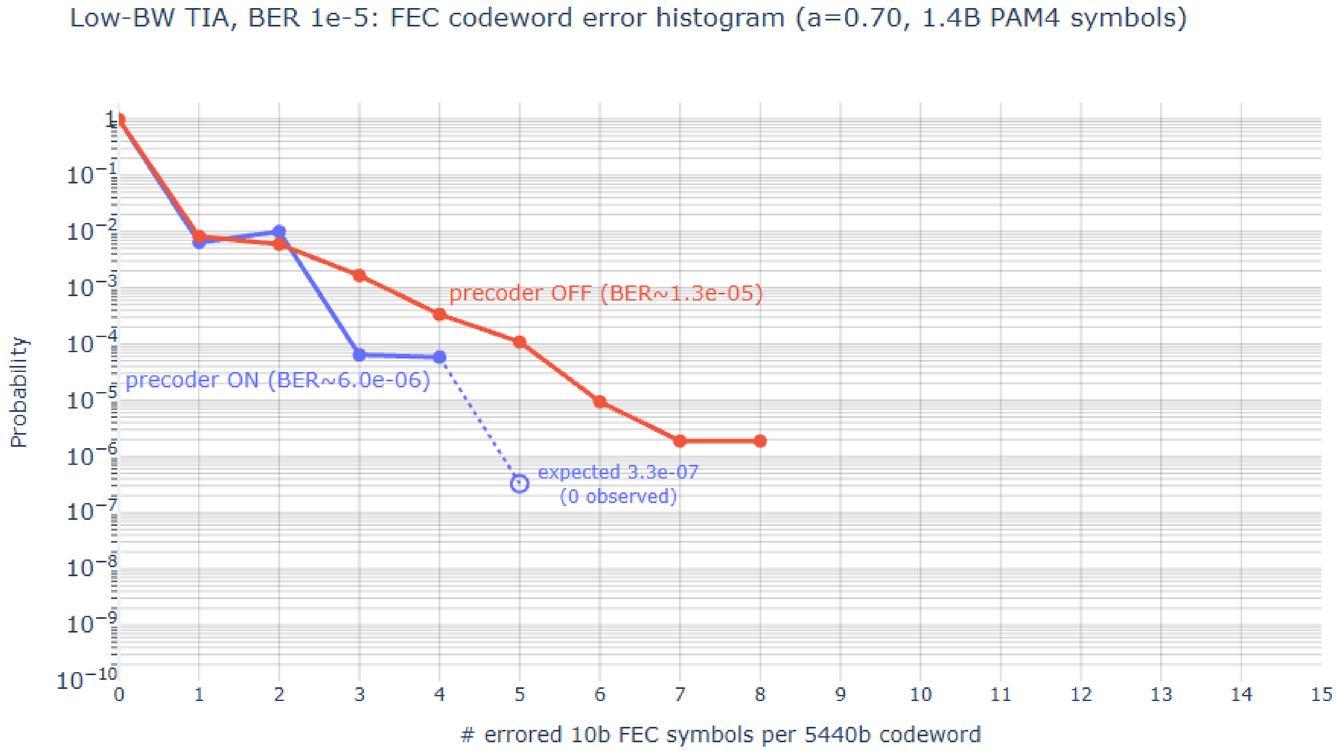




400G Optical Channel(22pA/rtHz, 76GHz TIA)

FFE + DFE





- Precoding is effective in eliminating error bursts
- Post-FEC performance is shown with 1-way RSFEC(544,514). 4-way will improve results further.

Summary

CPO based Optical channels

- This contribution proposes the baseline Optical channel specifications (400G-DR*n*) accommodate emerging technologies.
  - CPO could be taken into consideration without a new objective
- The reference Rx with FFE + 1-tap DFE can be sufficient for this purpose. A higher 1-tap DFE range of [0,0.7] will be help to cover these cases.
- Propose differential Precoding (MOD4/[1+D]) to mitigate/eliminate error propagation concerns due to larger DFE tap.
- Future presentations with more details will follow this initial proposal